

**STUDIES UPON THE FUNCTION OF THE PYLORUS  
AND STOMA AFTER GASTROENTEROSTOMY  
HAS BEEN PERFORMED.**

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A GREAT deal of speculation has been indulged in as to the physiological conditions which exist after the operation of gastroenterostomy. Undoubtedly the most important and thoroughly scientific and accurate observations were made by Cannon in his recent studies at the Harvard Medical School. Together with Murphy, he performed the operation of gastroenterostomy on a large number of cats, and after full post operative recovery, studied the animals' intestinal mechanism through the agency of the fluoroscope. He found according to these observations that all food was driven by the muscular contractions of the stomach through the pylorus, the stoma playing no practical part in alimentation. This was a profoundly important contribution.

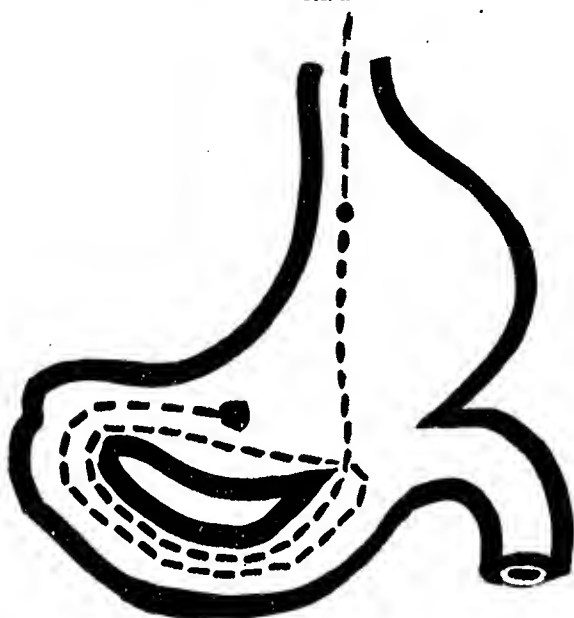
About a year ago, the class in operative surgery at the Surgical Research Laboratory at Columbia University performed the operation of gastroenterostomy. We were making some observations upon the efficacy of various forms of superficial dressings, and in this particular case, a certain dressing was applied upon a small piece of gauze. While not under observation, the animal picked out the smaller dressing from under the external bandage and swallowed it. Some time after this, he was chloroformed for the purposes of study, and upon opening his stomach, the gauze was found trailing through the stoma. We were immediately interested in this, because Cannon's observations had just been published. Unfortunately no record was made as to the direction taken by the tip of the gauze which had passed through the stoma. This is unfor-

tunate, because later observations suggest that solid bodies, which pass through the stoma, may all travel toward the pylorus.

During the past winter we determined to study this interesting problem of pyloric and stoma function and decided to investigate it from three standpoints, viz. (1) By studying the course taken by solid particles which were tied to a string. (2) By feeding fat and studying the condition of the lacteals an hour later. (3) By performing gastro-colostomy or gastro-ileostomy near to the valve and making observations upon the weight of the animal. For the feeding of string, no originality can be claimed, it having been used for many purposes notably by Abbe and Dunham. The particular purpose to which we have put it, however, we believe to be original. We conceived the idea that if gastroenterostomy were done and time allowed to elapse for the perfection of healing and for the establishment of any new physiological functions to which origin might be given by the operation, it would be fair to assume that solid food particles ordinarily passed on and digested, would take the same course as indigestible solid particles tied to string. The dogs accordingly underwent gastro-duodenostomy or gastro-jejunostomy, as the case might be, the technic being that of open incision and suture. Not less than two weeks later, they were permitted to swallow a piece of meat in which a small bullet, tied securely to the end of a piece of string, was embedded. A dog lends himself favorably to this manœuvre, because of his natural voracity. In an instant the meat, bullet and one end of the string are in his stomach. The next part of the procedure consists in anæsthetizing the animal to very profound narcosis. On separating the jaw very widely the pterygomaxillary ligament is brought clearly into view. The string being threaded on a short curved round needle is quickly passed through the ligament and tied. This should be done loosely so as not to cut through. Another point in the technic is that the string should not be tied to the meat: it being preferable probably to wrap it once or twice tightly around it.

The pterygo-maxillary ligament is situated so far aboral to the teeth that the animal does not bite the string off, and it remains hanging down the cesophagus. Its situation is so far

FIG. 1.



LINE DRAWING OF A SPECIMEN OBTAINED BY PERMITTING A DOG TO SWALLOW A PIECE OF STRING. BAG OF SHOT TIED TO END PASSED THROUGH THE STOMA, DUODENUM AND PYLORUS TWICE. THE SAME FORCES MAY CARRY MURPHY BUTTONS FROM THE QUT INTO THE STOMACH.

STRING TIED IN PHARYNX TO PTERYGO-MAXILLARY LIGAMENT.

back in the pharynx that the string will remain for days in this position without creating any choking or discomfort of any kind whatsoever.

It is difficult to get the string to pass out of the stomach. If it is too long, it simply rolls up and lies in the stomach

imbedded in a mass of mucus and food. If too short, it will obviously not have the requisite length to give a demonstration of the facts under investigation. We are fortunate in having secured a specimen which Dr. Brown has mounted very beautifully, and of which both a photograph and a line drawing are shown in the illustrations Figs. I and II; it will be seen that the bag of shot passed directly into the stoma and instead of travelling aboral, it proceeded oral, Fig. II, toward the pylorus through it and into the stomach. Following the trail of string which it left behind, it can again be traced over exactly the same ground. This study appears to prove that at least under certain conditions and at certain times solid materials do pass through the stoma even when the pylorus is left untouched and it is in normal condition. This is further suggested by Fig. III, which shows a piece of *bone* lodged in the stoma. The results of further string feeding are shown in Fig. IV. This string passed direct through the pylorus. Thus some strings pass one way and some the other way. Figs. V and VI illustrate the same point.

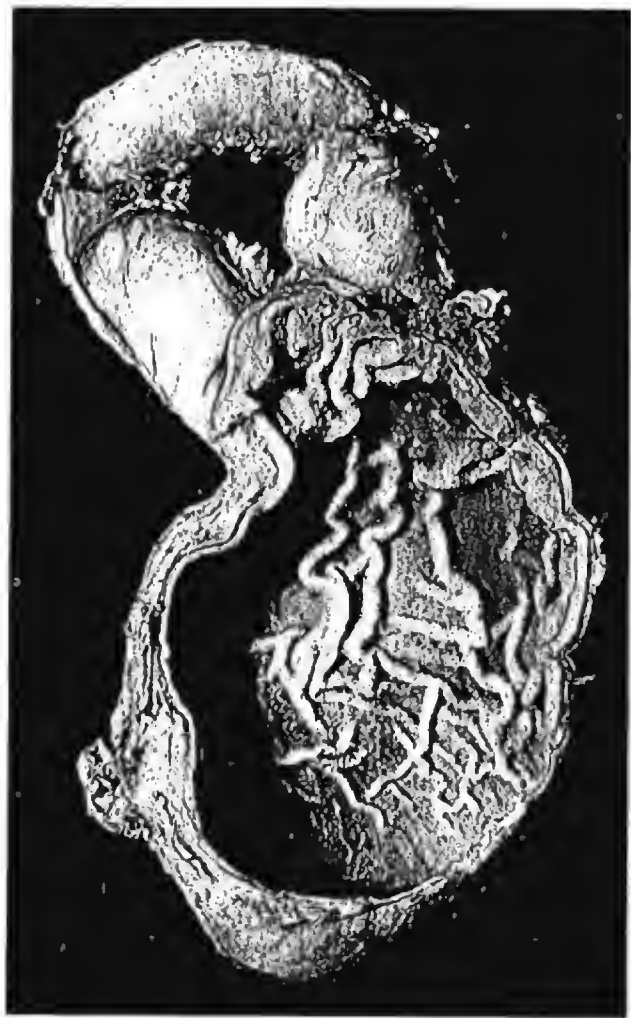
*Pyloro Stoma Function as Demonstrated by the Lymphatics.*—We are fortunate in being able to report one case which lent itself very favorably to this demonstration. We had fed the dog string, and it had worn the string for the usual period of about 24 to 48 hours, when we determined to feed it fat prior to chloroforming it. About one hour after the fat meal, the animal was opened under profound anæsthesia. The gastro-ileostomy had been situated near to the ilio cecal valve, as shown in Fig. VII. By good fortune the mass of meat in which the string with its shot had been imbedded proved to be of a very indigestible type, and it was discovered considerably macerated but still in statu-quo lodged in the ileum about 20 centimeters oral to the stoma. The lymphatics of the duodenum from the very beginning of the mid gut, viz., some four to five centimeters aboral to the pylorus, were loaded and distended with emulsion. This, parenthetically, affords a convenient means of observing the similarity in function of the stomach and first portion of the duodenum from which no

FIG. 11.



Photograph of specimen from which Fig. 1 was made.

FIG. III.



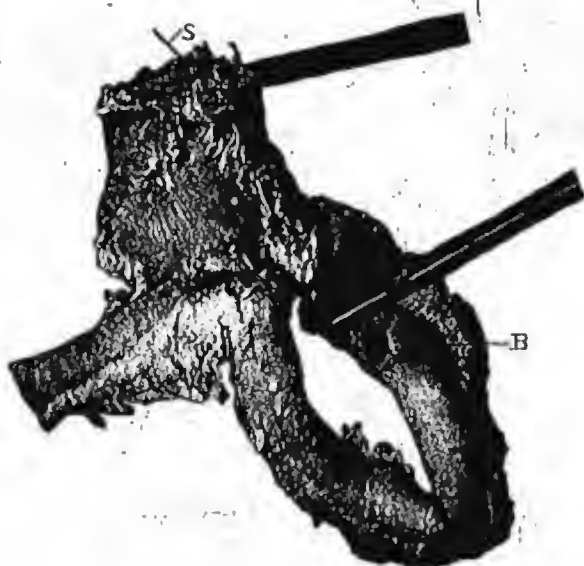
Studies in the Functions of the Pylorus.

FIG. IV.



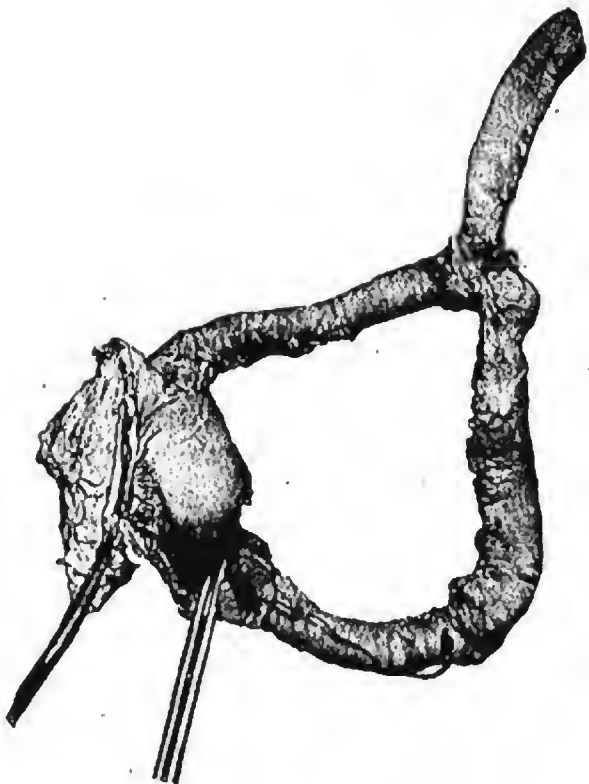
Studies on Functions of Pylorus, etc.

FIG. V.



Photograph of specimen of gastro jejunostomy after string had been fed. The clamps were applied before specimen was removed so as to be certain that string was held in primary position. Note string at S; cesophagus and bullet on aboral end at B, where duodenum was cut.

FIG. VI.



Y gastro-enterostomy. Clamps applied as in Fig. V. Opening shows string which, with bullet, had passed through pylorus. This is suggestive for stoma drainage and was very perfect owing to end to side implantation of gut at stoma.

absorption whatsoever seemed to be taking place, two structures morphologically very dissimilar, but shown functionally to have a common origin in the primitive foregut.



Fig. VII.

THIS DOG SWALLOWED MEAT WITH STRING ATTACHED. TWO DAYS LATER WAS FED FAT. KILLED ONE HOUR LATER, LYMPHATICS ORAL TO POINT M, WHERE MEAT LODGED IN GUT, WERE GORGED. THOSE ABORAL TO M WERE EMPTY. PROVES THAT FATS DO NOT PASS THROUGH STOMA.

The lymphatics of the entire intestine from the second portion of the duodenum down were well filled. This lymphatic congestion terminated abruptly opposite the piece of meat which was lodged in the ileum and held there in place by

the string. On the aboral side, viz., for a distance of about 20 centimeters between the lodged meat and the stoma, it was positively demonstrated that no absorption whatsoever was taking place. Aboral to the stoma there was also no lymphatic engorgement. In this particular case, it therefore seemed that probably no fat had passed through the stoma; that all had gone through the pylorus. This, of course, presupposed that pancreatic secretion had passed beyond the meat.

These two studies are suggestive and are to be followed by more of a similar nature which are in course of preparation at the laboratory. It may well be that some slight variation in the technic as to length of loop, direction of incision in the stomach wall, position on anterior or posterior wall, mode of attachment of intestine to stomach and other even less significant factors may play parts at present entirely unknown in determining the function of the stoma in the presence of an unobstructed and natural pylorus. It has been thought (Mayo and others) that the stoma should be made at the most dependent portion of the stomach in order to functionate. This can be readily understood to be of great importance in the presence of atonic dilatation and pyloric obstruction. Our experiments, as yet incomplete, seem so far to show that the position of the stoma makes no difference in its function, at least we have not as yet been able to determine that it does.

*Observations on Stoma Function by Recording the Weight of the Animal.*—If a gastro-ileostomy be done very near the valve or if one goes so far as to perform gastro-colestomy, a study of the weight of the animal after this operation cannot fail to throw some interesting light upon the function of the stoma. Moreover observations on the feces are also not without importance, because if passed directly through the stoma, they would not have undergone digestive processes. Graphic charts of the weights of our animals have not yet been made, neither have the feces been examined microscopically or chemically. Gross examination however has as yet failed to show any difference in the feces of dogs operated on in this manner from those of unoperated dogs, and our observations

on weight appear to show that for a time after operation the dogs, usually thin and in rather poor condition, having been half starved on the streets, frequently gain in weight for about a week. They are then apt to lose weight rapidly for a week, and even though fed carefully with milk and dog biscuits, are prone to die at the end of the second or third week from inanition. Autopsy findings rather constantly show the long loop to be somewhat dilated and filled with soft grumous material. Pretty well marked spur formation at the side of the stoma has been a constant feature in these cases. Further study alone by means of feeding string and fat by the technique and at the times heretofore described will alone answer the question why these dogs should at first gain, then lose weight and why inanition and exitus should subvene so rapidly. It is not improbable that the profound nutritional changes that certainly do accompany many of these stoma experiments are due (Turck) to interference with normal colon bacillus action or to the establishment of chemical reaction unfavorable to digestion. In any event the experiments support Blake's contention that gastroenterostomy should not be done except in the presence of pyloric stenosis.